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## **FGD By-Products as an Agronomic Lime Substitute: A Case Study**

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**Project: Land Application Uses For Dry FGD By-Products**

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# FGD By-Products as an Agronomic Lime Substitute: A Case Study

By

D. Lynn Forster and Jon Rausch

## Abstract

The following analysis is based upon the potential use of dry FGD by-product as an agricultural lime substitute. In order to make this case study comparison, representative farms are developed in two regions of Ohio, and depict average agricultural liming practices for these regions. These geographic regions, northwest and northeast quadrants of the state, are expected to be representative of all farms in the specified region. Thus, represent the average farm operation in that region.

These two geographic regions account for 60 percent of the agricultural lime usage in Ohio: 34 percent of Ohio agricultural lime is used in the northwestern region, and 26 percent in the northeastern region. These regions also represent extremes in market conditions for agricultural lime and the FGD by-product: in contrast to the northeast region, the northwest region tends to have higher soil pH, lower agricultural lime application rates, closer distances to limestone quarries, and farther distances to potential FGD sources. Given these characteristics, the northwest region would appear to present weaker market opportunities for the dry FGD by-product than would the northeastern region.

This preliminary comparison of representative farms points to potential problems in marketing dry FGD by-products in agricultural markets. First, the potential market for dry FGD by-products in agriculture is limited since it is to serve as a substitute for agricultural lime. While agricultural lime is used widely, demand for the product is unlikely to grow dramatically in the future. Second, both agricultural lime and dry FGD by-product are bulky materials, and transportation is the most significant component of the total cost. Since total neutralizing power (TNP) of the dry FGD by-product is less than that of agricultural lime, use of the dry FGD by-product requires relatively more bulk or quantity to be hauled and spread. Third, dry FGD by-product's use on agricultural land may be feasible on cropland near its source (electric power plants); however, it may not be economically competitive with agricultural lime on cropland more distant from potential source(s) this by-product.

This paper reports on a preliminary analysis of the FGD by-product as an agricultural lime substitute which requires making a farm level comparison of current agricultural liming practices with those of the proposed substitute. In order to make this comparison, representative farms are developed for each region (Figure 1) and depict current and proposed alternative liming practices for these farms. An average farm is developed for each of these two geographic regions, the northwest and northeast quadrants of the state (Figure 1).

These two regions account for 60 percent of the agricultural lime usage in Ohio: 34 percent of Ohio lime is used in the northwestern region, and 26 percent in the northeastern region. These regions also represent extremes in market conditions for agricultural lime and the FGD by-product: in contrast to the northeast region, the northwest region tends to have higher soil pH, lower agricultural lime application rates, closer distances to limestone quarries, and farther distances to potential FGD sources. Given these characteristics, the northwest region would appear to present weaker market opportunities for the FGD by-product than would the northeastern region. Farm types in the NW generalize to the SW and in the NE to the SE reasonably well.

### **Farm Selection**

Using the Ohio Farm Household Longitudinal Study (1990), a representative farm for each geographic region is constructed. The Ohio Farm Household Longitudinal Survey is a stratified sample, which is representative of Ohio farm households. Thus, mean farm size and agricultural practices for farms in the sample should be representative of average farming practices within these regions. Thus, the case farm developed for each geographic region is a composite or average farm for the region based upon this representative sample.

The boundaries for each region are shown in Figure 1. As illustrated by the crops grown on these representative farms, land use differs between these two regions (Figure 2). In the northwest, corn and soybeans are grown on almost 80 percent of the cropland, compared to about 60 percent in the northeast. Hay is an important crop in the northeast, but it is grown on a relatively small proportion of the cropland in the northwest.

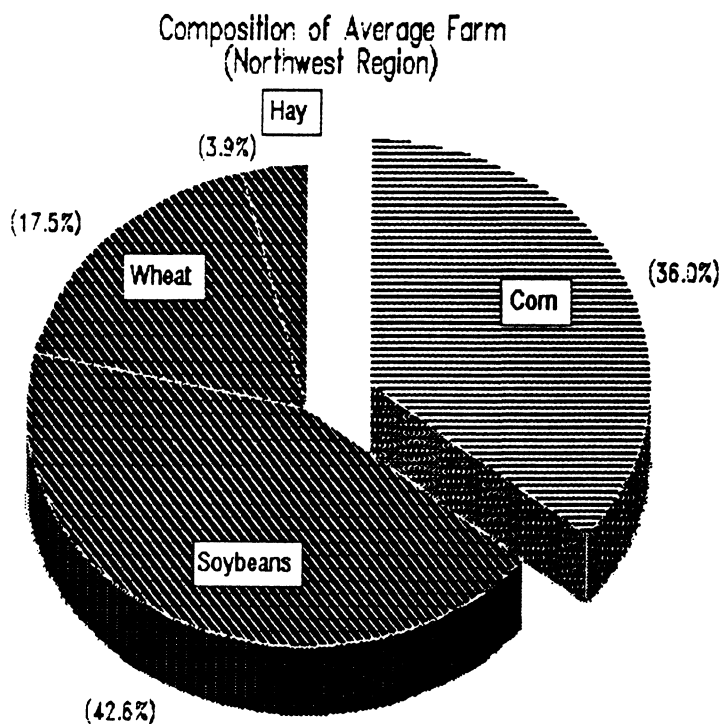
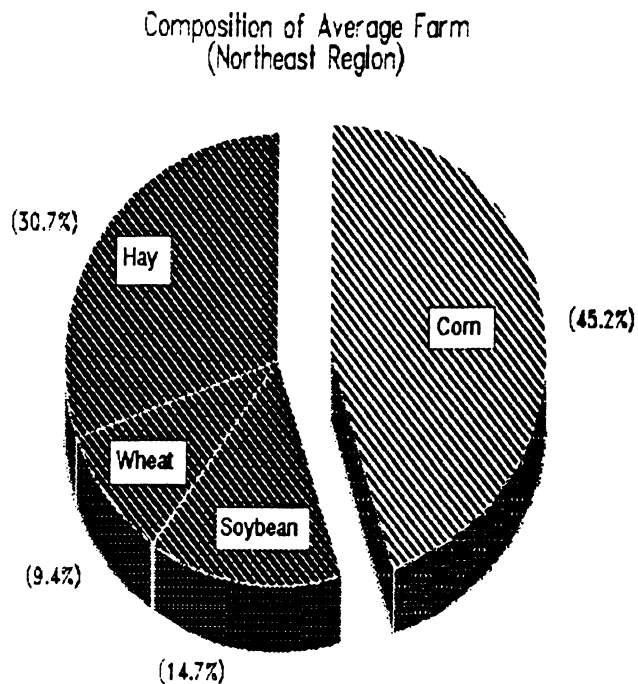
### **Agricultural Lime Use**

Agricultural lime application rates are estimated using the average soil pH and average lime test indexes (LTI) for each region (OARDC). From this information lime application rates are estimated, assuming a pH of 7.0 is desired (Table 1). These rates of application for the representative farms are far less than farmers actually apply. From 1986-91, farmers spent about \$0.07 per acre on agricultural lime in the northwest and about \$0.18 per acre in the northeast, which is in sharp contrast to the \$6-\$12 per acre agricultural lime costs projected in these budgets. However, application rates used in this analysis reflect the potential for agricultural lime and the FGD by-product.

**Figure 1** Geographic boundries for Northwest and Northeast regions, and estimated agricultural lime useage (tons) by Ohio county.



**Figure 2** Composition of average Ohio farm by geographic region (Northeast Region has an average of 246 acres per farm while Northwest Region averages 471 acres per farm).



For each representative farm, agricultural lime costs were estimated from telephone conversations with individuals who provide liming services. Estimates quoted for wholesale lime are about \$5.00 per ton for both regions. Lower transportation costs of agricultural lime to the northwest reflects the fact that northwest Ohio farms are in closer proximity to limestone quarries than are farms in the northeastern part of the state. Transportation costs are \$8 per ton for the northwest region and \$11.50 per ton for the northeast region. Spreading costs are expected to be the same for both regions and are estimated at \$3.50 per ton. Again, the source of these cost estimates is agricultural lime dealers. It is assumed that liming occurs on average every five years, thus total lime costs have been amortized over their expected life at an 8 percent interest rate annually.

Due to higher soil pH in the northwestern region, lime application rates are lower for the representative farm in the northwest than the one in the northeast (Table 1). The amortized lime cost per acre also is lower on the northwest farm (\$5.79 per acre) than on the northeast farm (\$12.02), due to these lower application rates and to the lower costs of transporting agricultural lime from quarries to farms.

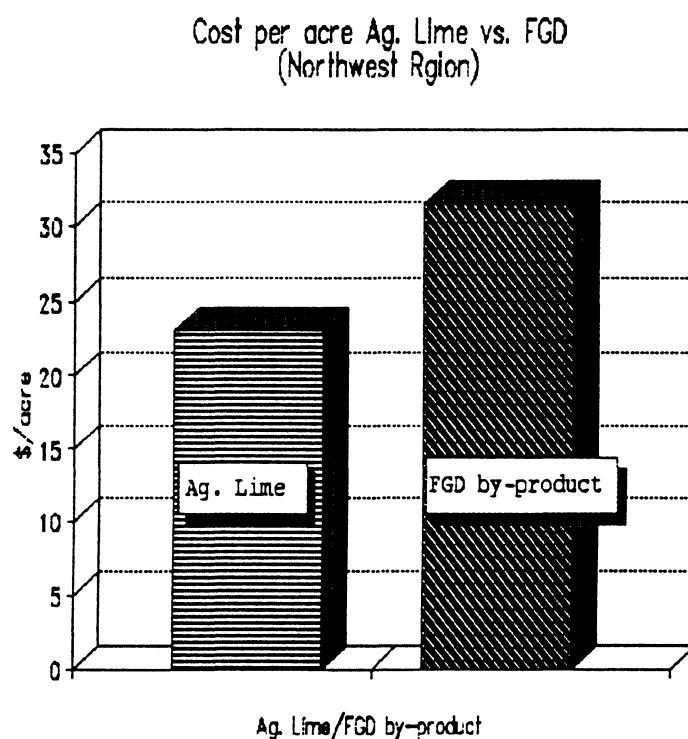
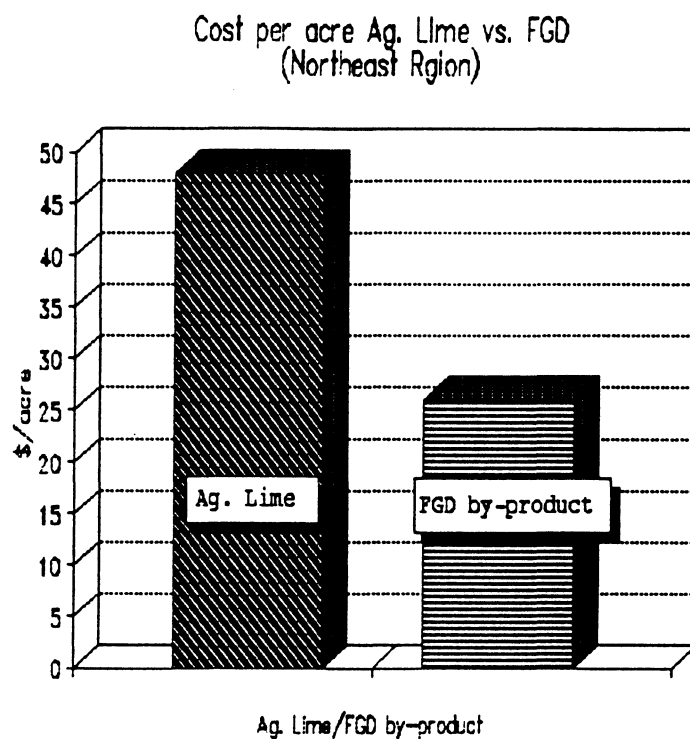
The results of the agricultural lime budget suggest that although the two regions differ with respect to lime cost per ton, farm size, and composition of crops grown, the total costs associated with liming on the two farms are not substantially different. Total agricultural liming cost for the typical farm in the northwest is estimated to be \$10,882 and the northeast to be \$10,671. Amortizing these costs over a five year life expectancy yields an annual cost of about \$2,725 and \$2,956 for the northwest and northeast regions, respectively.

#### **FGD By-Product Use**

The use of the dry FGD by-product as a substitute for agricultural lime is estimated in the same manner as agricultural lime, with the only differences being the cost of the product and the quantity applied. That is, there is no charge for the by-product material at its source. The costs incurred by users are associated with transportation of the product to the application site and its application. It is also assumed that the dry FGD by-product is 60 percent as effective in total neutralizing power (TNP) and has physical properties similar to agricultural lime. Under these assumptions more product must be applied to achieve desired results. Specialized equipment may be required for transportation and application, but per ton transportation and application costs are assumed to be similar for the FGD by-product and lime.

For the purpose of estimating transportation costs, this analysis represents a power plant in Lorain transporting the by-product to farms in Hancock county (Northwest) and Wayne county (Northeast). Transportation costs are estimated to be \$0.10 per ton per mile. It is estimated that 100 miles are traveled from the FGD source to the representative farm in this region at an average cost of about \$10 per ton. The northeast region tends to be closer

**Figure 4** Comparison of average application cost estimates for each geographic region of Ohio.



to the source of the by-product, and a 30 mile distance is used to estimate the average cost of transportation in this region, or about \$3 per ton. Application cost per ton is expected to be the same as for the FGD by-product as for agricultural lime, and a \$3.50 per ton application cost is assumed.

The results of the FGD by-product budgets estimate the total by-product cost for the northwestern farm are \$14,838 and \$6,393 for the northeastern farm (Table 2). Amortizing these costs over a five year period at 8 percent interest provides an estimated annual cost of \$3,716 and \$1,601 for the northwestern and northeastern farms, respectively. Total costs associated with the by-product as an agricultural lime substitute is substantially less for the northeast region and substantially higher for the northwest region, relative to agricultural lime (Figure 3). This cost difference is primarily a function of the reduced costs associated with transporting the by-product shorter distances in the northeast region.

### **Implications for FGD By-Product Use**

This preliminary comparison of representative farms points to potential problems in marketing FGD by-products in agricultural markets. First, the potential market for FGD by-products in agriculture is limited since it is to serve as a substitute for agricultural lime. While agricultural lime is used widely, demand for the product is unlikely to grow dramatically in the future. Second, both agricultural lime and the FGD by-product are bulky materials, and transportation is the most important component of their total cost. Since total neutralizing power of the FGD by-product is less than that of agricultural lime, use of the FGD by-product requires relatively more bulk to be hauled and spread. Third, the FGD by-product's use on agricultural land may be feasible on cropland near its source (electric power plants); however, it may not be economically competitive with agricultural lime on cropland distant from its source.

Electric utilities might find it feasible to subsidize FGD by-product use in agriculture to avoid incurring landfilling costs. If the power plant were to bear all or a major part of the transportation costs, the FGD by-product might be competitive with agricultural lime over most of Ohio. Analysis of the SE and SW regions of Ohio is needed and more precise estimates for all regions of Ohio will be possible when actual field data are available in Phase II.



**Table 1. Lime Usage and Cost on Representative Northwestern and Northeastern Ohio Farms.**

Crop	Acres	Lime to pH 7.0 (T/A)	Tons Requ- ired	Freight \$/Acre	Application \$/Acre	Total Cost	Amortized 5 Yrs @ 8%
<b>Northwest Sec- tor</b>							
	169.68	1.40	237.55	18.20	4.9	3919.54	981.67
Corn	200.91	1.40	281.28	18.20	4.9	4641.04	1162.38
Soybean	82.34	1.40	115.27	18.20	4.9	1902.03	476.38
Wheat	18.15	1.40	25.41	18.20	4.9	419.26	105.01
Hay							
Total	471.08		659.51			10881.88	2725.44
Cost per Acre						23.10	5.79
Avg. Soil pH: 6.49							
Avg. Lime Test Index: 68.35							
<b>Northeast Sec- tor</b>							
	111.20	2.40	266.88	39.60	8.4	5337.50	1336.81
Corn	36.24	2.40	86.97	39.60	8.4	1739.42	435.65
Soybean	23.08	2.40	55.39	39.60	8.4	1107.79	277.45
Wheat	75.37	2.40	180.90	39.60	8.4	3617.95	906.14
Hay							
Total	245.89		590.13			11802.67	2956.06
Cost per Acre						48.00	12.02
Avg. Soil pH: 6.20							
Avg. Lime Test Index: 67.62							

**Table 2. FGD By-Product Usage and Cost on Representative Northwestern and Northeastern Ohio Farms.**

Crop	Acres	Lime to pH 7.0 (T/A)	Tons Required	Freight \$/Acre	Ap- plication \$/Acre	Total Cost	Amortized 5 Yrs @ 8%
<b>Northwest Sector</b>							
Corn	169.68	2.33	395.91	23.33	8.17	5344.83	1338.65
Soybean	200.91	2.33	468.79	23.33	8.17	6328.70	1585.06
Wheat	82.34	2.33	192.12	23.33	8.17	2593.68	649.60
Hay	18.15	2.33	42.35	23.33	8.17	571.73	143.19
Total	471.08		1099.18			14838.93	3716.50
Cost per Acre						31.50	7.89
Avg. Soil pH: 6.49							
Avg. Lime Test Index: 68.35							
<b>Northeast Sector</b>							
Corn	111.20	4.00	444.79	12.00	14.00	2891.15	724.11
Soybean	36.24	4.00	144.95	12.00	14.00	942.19	235.98
Wheat	23.08	4.00	92.32	12.00	14.00	600.05	150.29
Hay	75.37	4.00	301.50	12.00	14.00	1959.72	490.83
Total	245.89		983.56			6393.11	1601.20
Cost per Acre						26.00	6.51
Avg. Soil pH: 6.20							
Avg. Lime Test Index: 67.62							